

References

- 1) **So et al (JP09-215982, own application)**: single electrode and a batch device for electrochemical reaction in hydrothermal cond.
- 2) **Spears (US5,599,296)**: apparatus for gas saturation of liquids by increasing partial pressure of gas preventing gas bubbles.
- 3) **Gilchrist (US3,798,150)**: multiple tubular electrolytic cells and pressure apparatus for separation of electrodepositable material from liquids operating at 54-64°C.
- 4) **Stralser (US3,975,247)**: concentrically tubular electrolytic cells apparatus for treatment of swages for recovering water and solids; room temperature (15-26°C) .
- 5) **Yuasa et al (JP09-117782)**: Hydrothermal oxidation method and apparatus for treating ammonia waste using catalyst and oxidizer.
- 6) **Pitora et al (SU 962212)**: Electrochemical apparatus using conductive particles for treatment of wastewater (No suggestion of Hydrothermal)
- 7) **Hess et al (US3,652,405)**: Hydrothermal (400-750°C) method and apparatus for treatment of municipal refuse and sewage with separation of solids products by hydrocyclones and filters).

Low temperature(<100°C)
Electrochemical process

Hydrothermal(>100°C)
Process

Gilchrist
Stralser
Pitara

Yuasa et al
Hess et al

Small scale
Hydrothermal Electrolytic

Gas dissolution
In Liquids

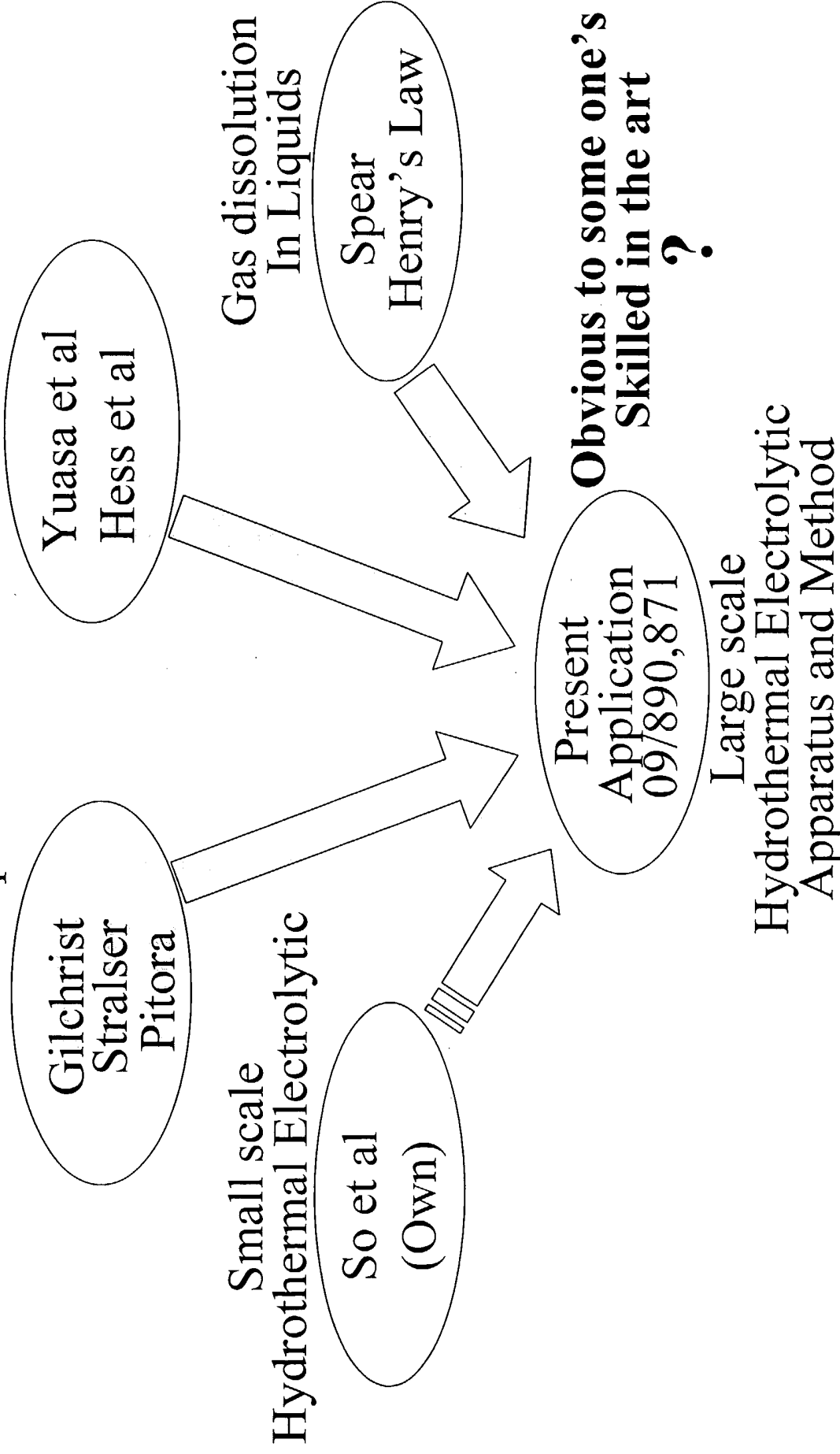
So et al
(Own)

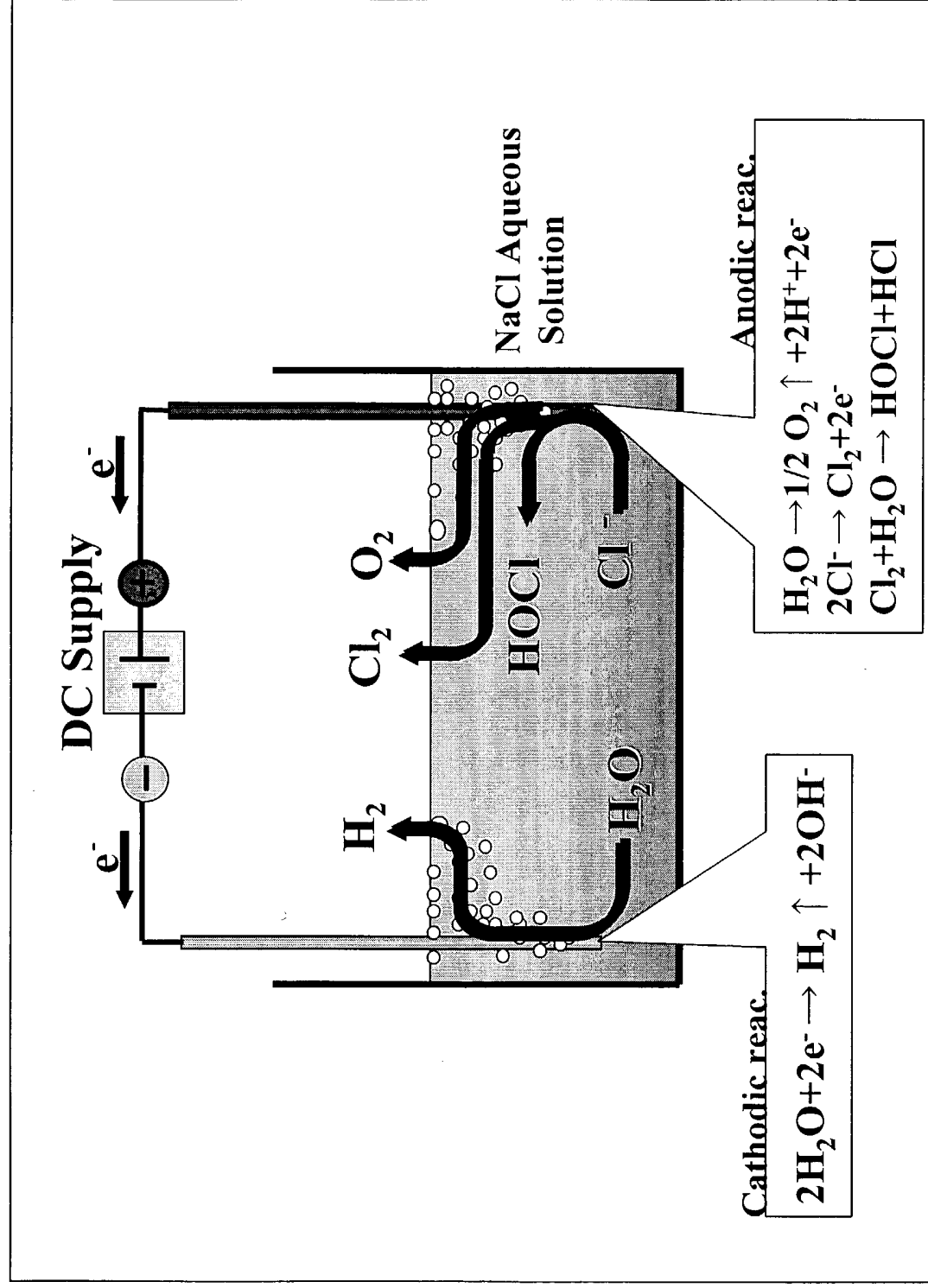
Spear
Henry's Law

Present
Application
09/890,871

Obvious to some one's
Skilled in the art
?

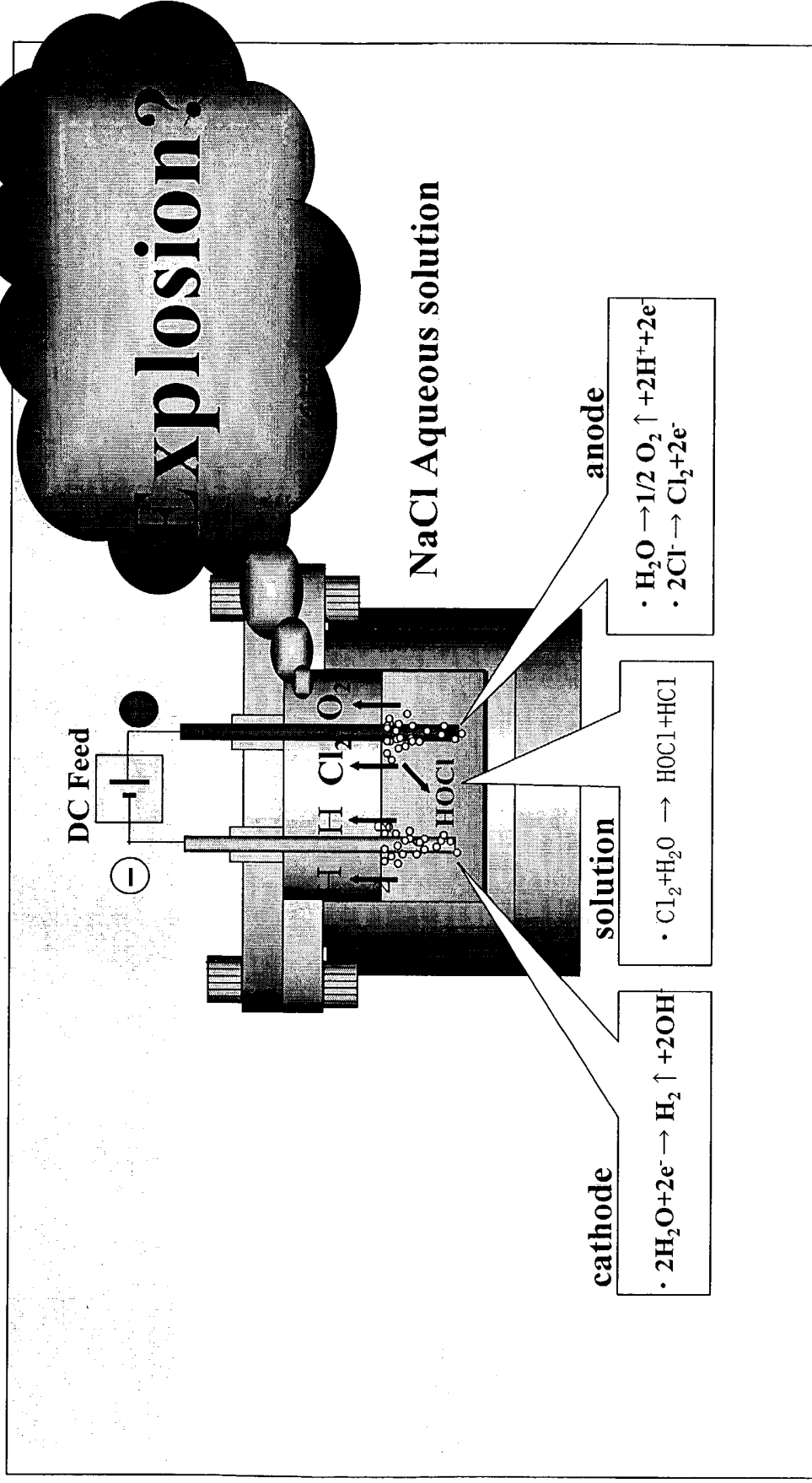
Large scale
Hydrothermal Electrolytic
Apparatus and Method

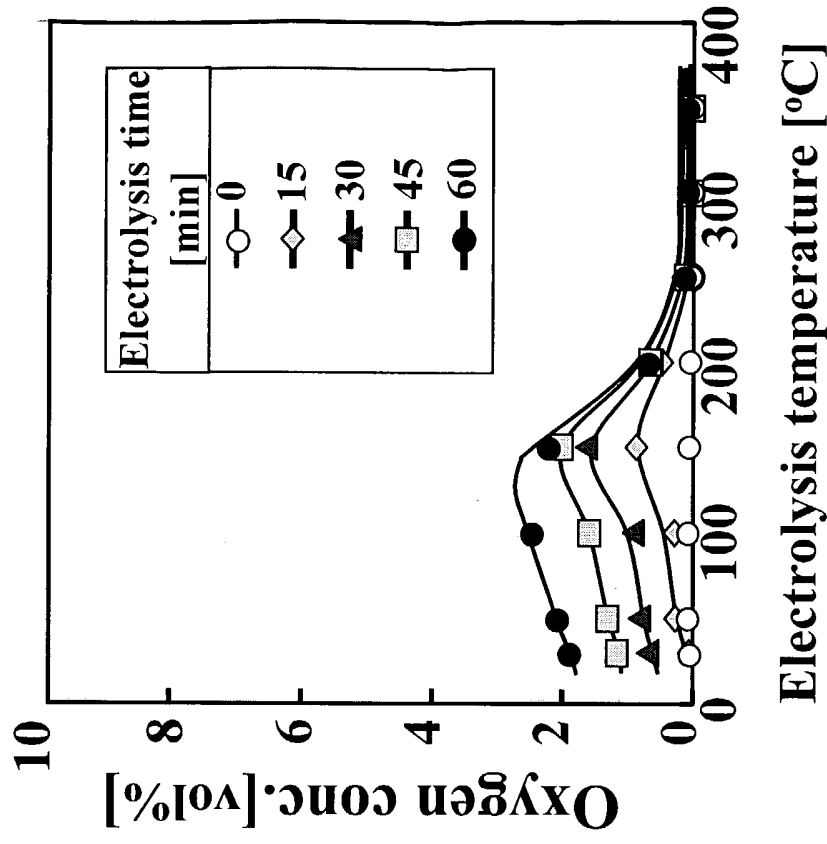
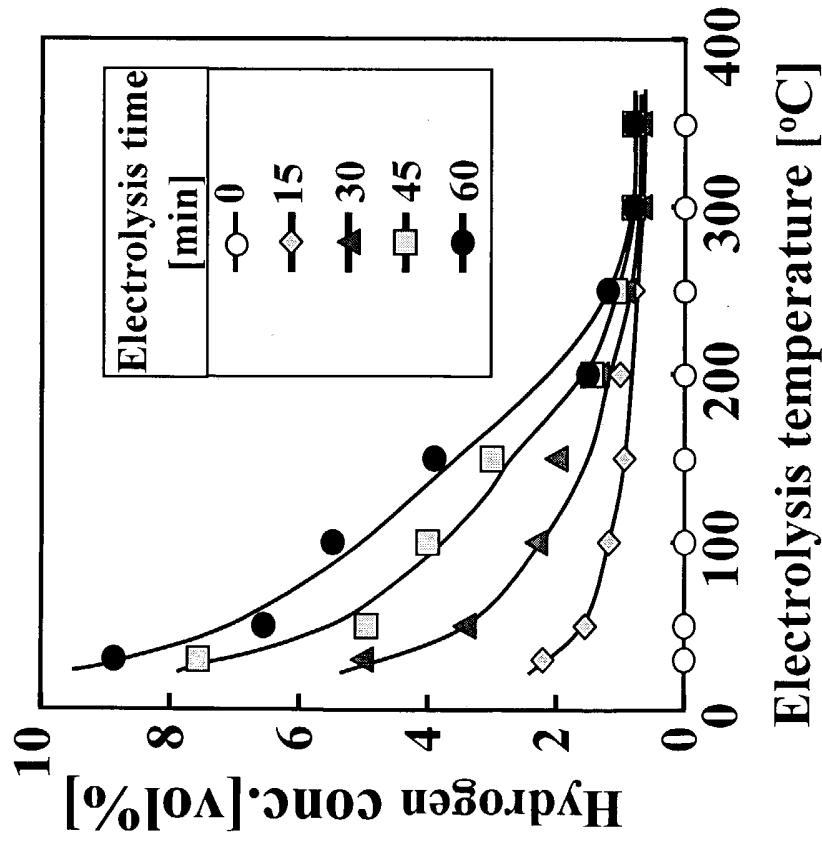




What is known: Electrolysis of aqueous solution at up to 100°C

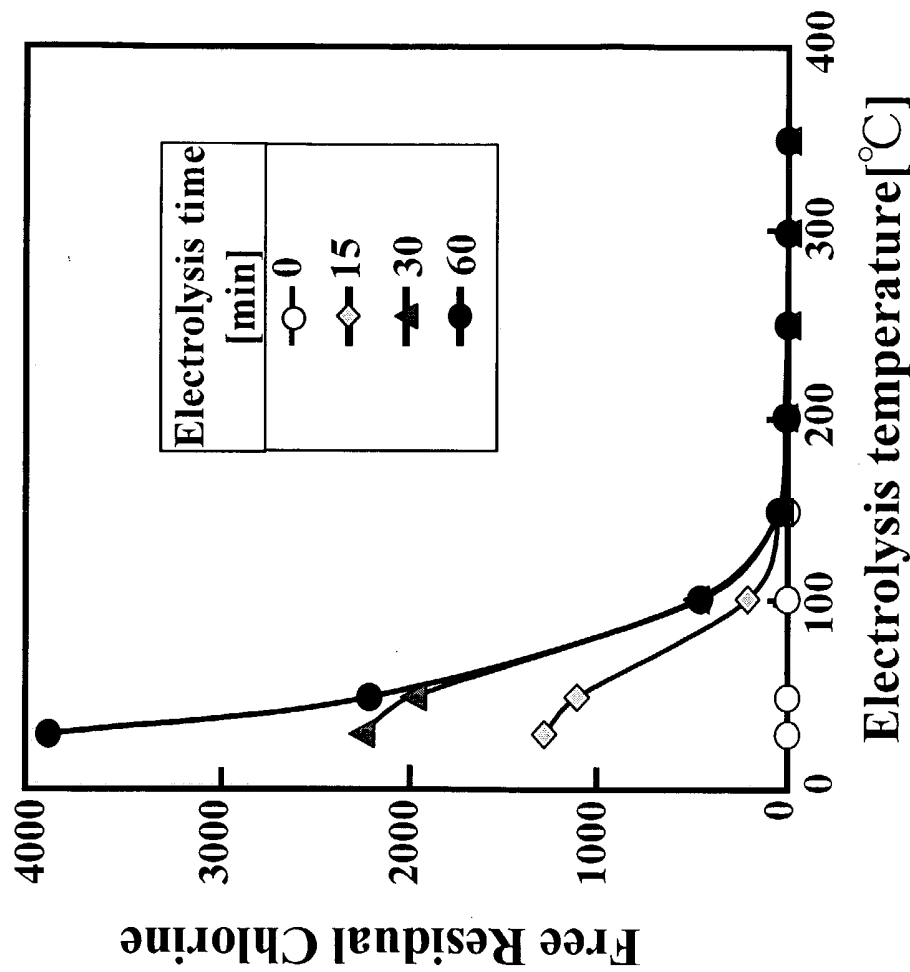
Non Obviousness of combination of prior art: Electrochemical reaction + Hydrothermal reaction + Large scale reaction





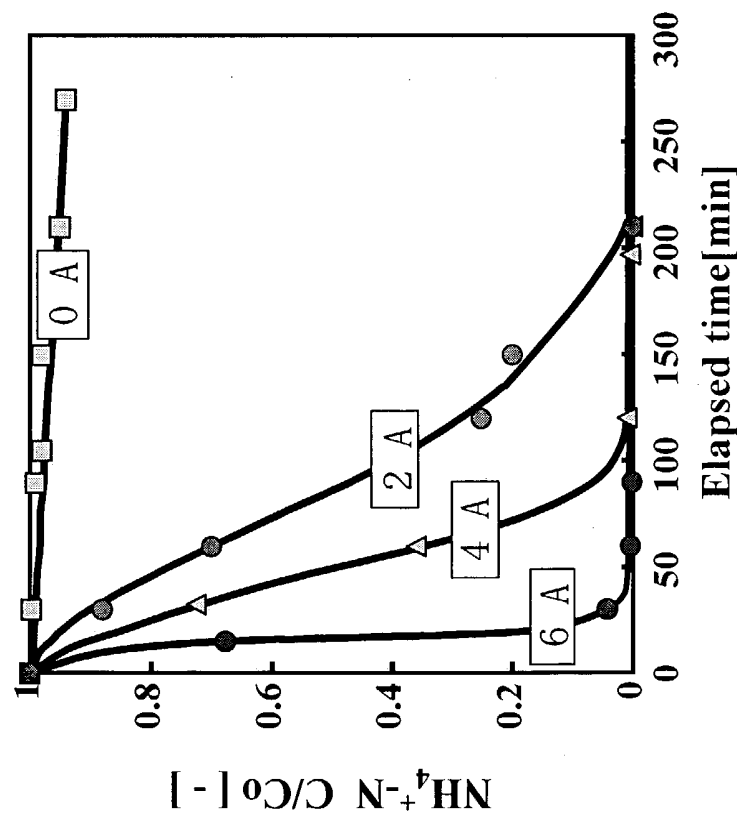
Influence of temperature on the electrolysis of aqueous NaCl solution: gas product

150mL NaCl 2wt%, DC 2A, initial charged gas 3MPa Ar

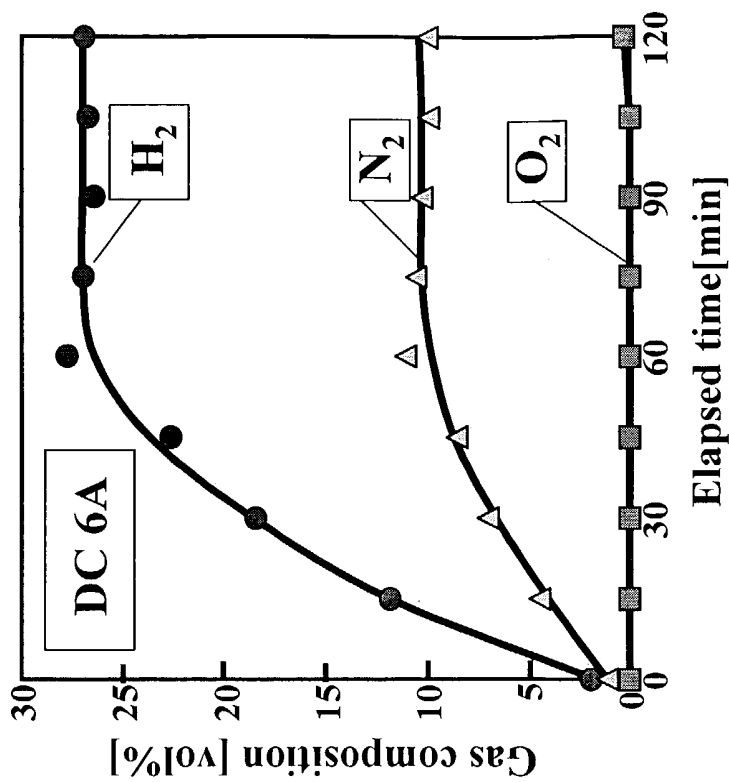


Influence of temperature on the electrolysis of aqueous NaCl solution : HOCl analysis

150mL NaCl 2wt%, DC 2A, initial charged gas 3MPa Ar



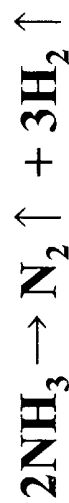
$\text{NH}_4^+\text{-N}$ Concentration profile

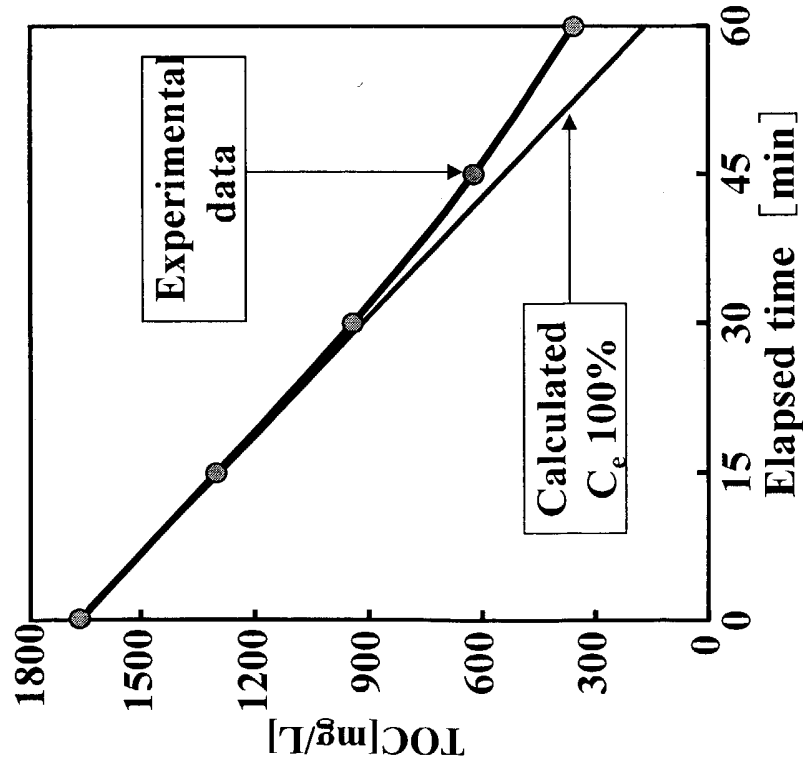


Gas Composition profile

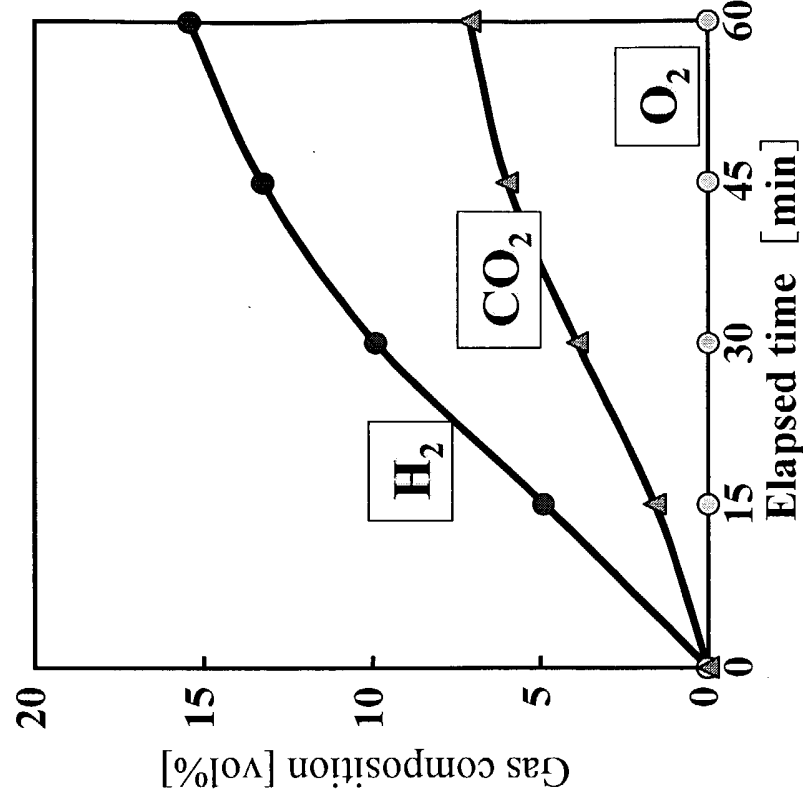
Electrochemical Oxidation of Ammonia at subcritical water conditions

Reaction conditions: Initial $\text{NH}_4^+\text{-N}$, 3,000mg/L T, 250 °C P, 7MPa NaCl, 2wt%





TOC removal profile

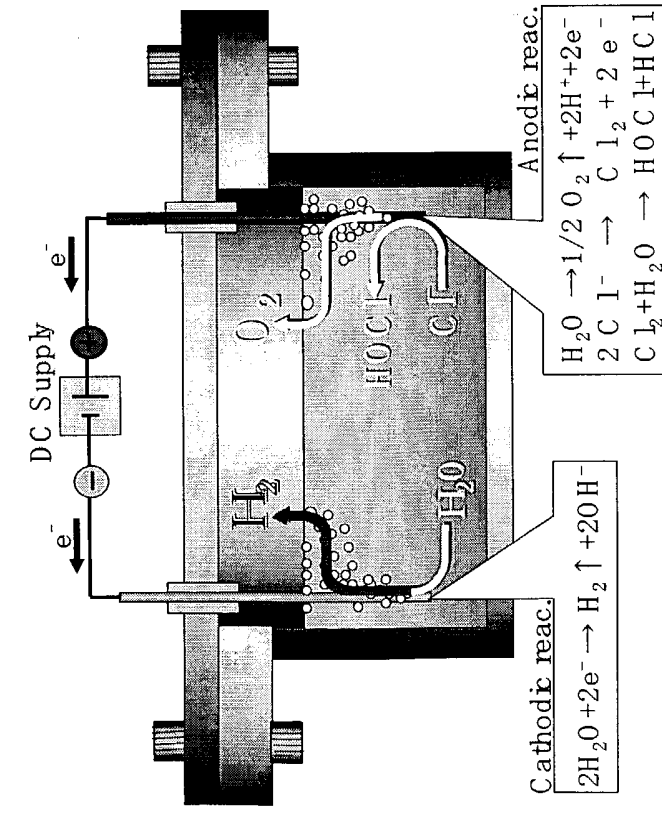


Gas composition profile

Current Efficiency for electrochemical oxidation of acetic acid

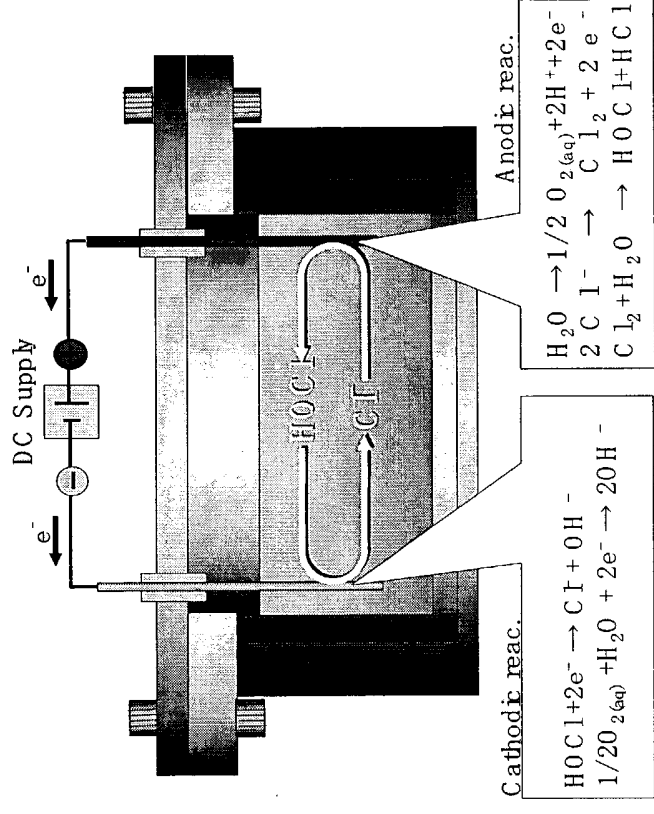
Experimental condition: Acetic Acid, 4,000mg/L; T, 250°C ; P, 7MPa; NaCl, 2wt%; DC, 2A





~100°C

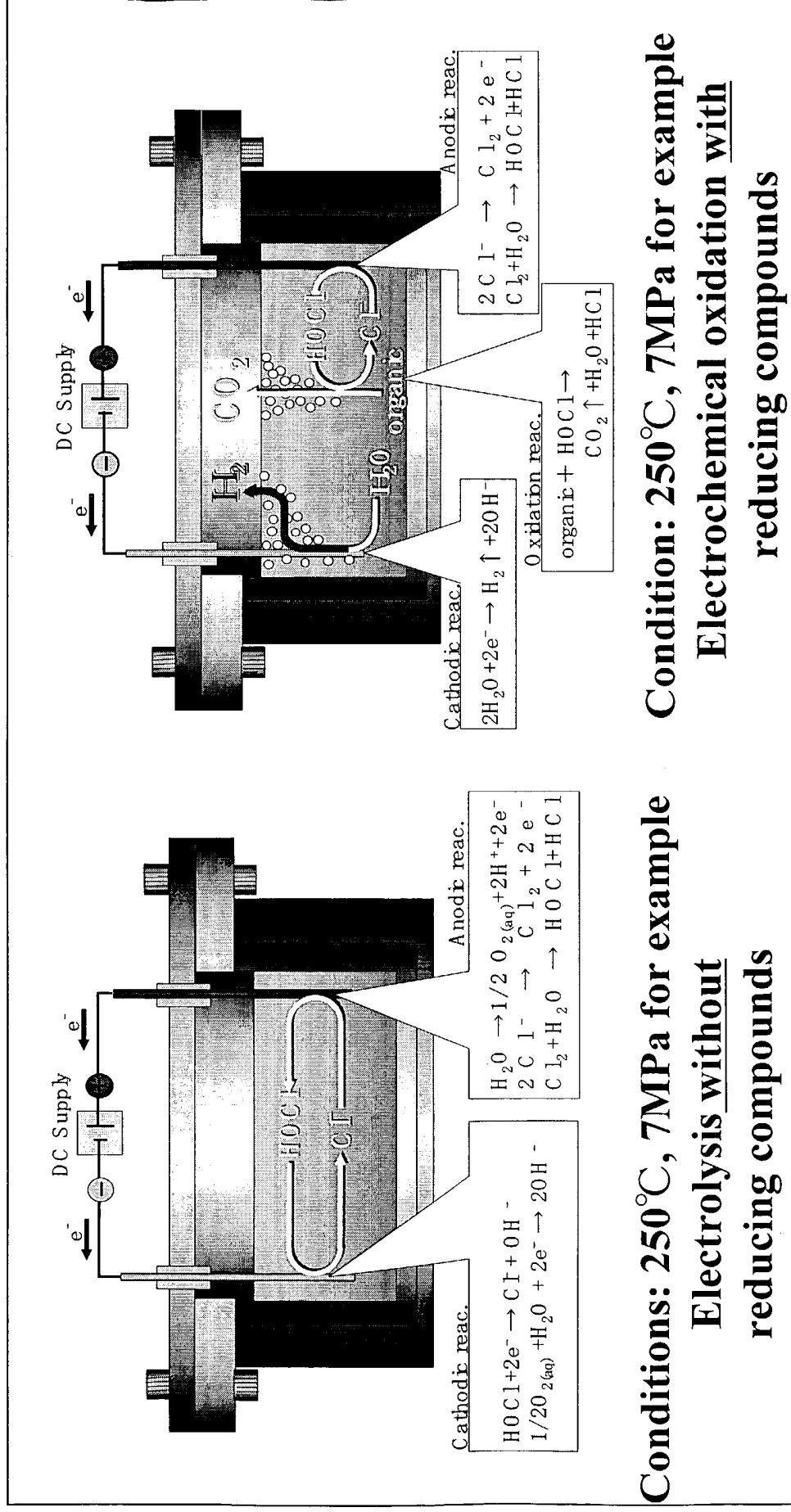
Conventional Electrolysis



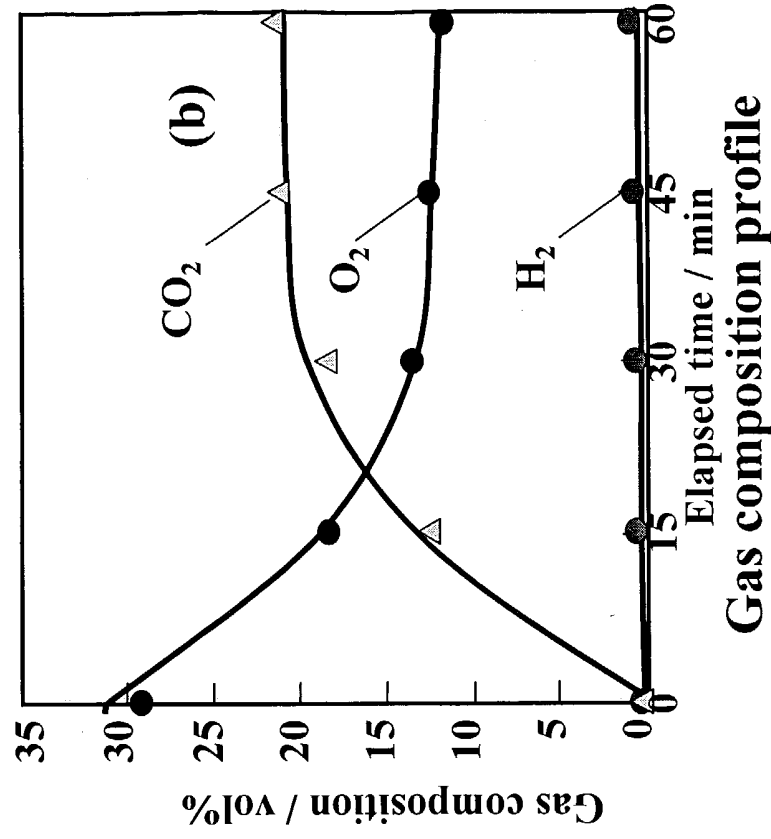
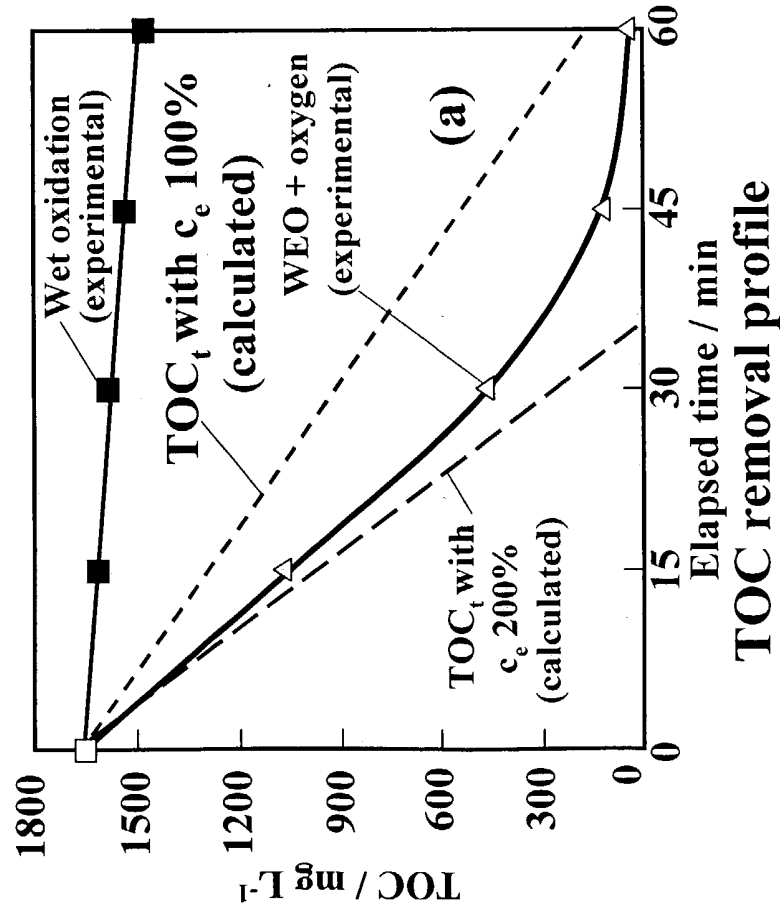
250°C, 7MPa

Hydrothermal water electrolysis

Reaction scheme for electrochemical reaction
of aqueous NaCl (strong acidic ions)
at hydrothermal conditions



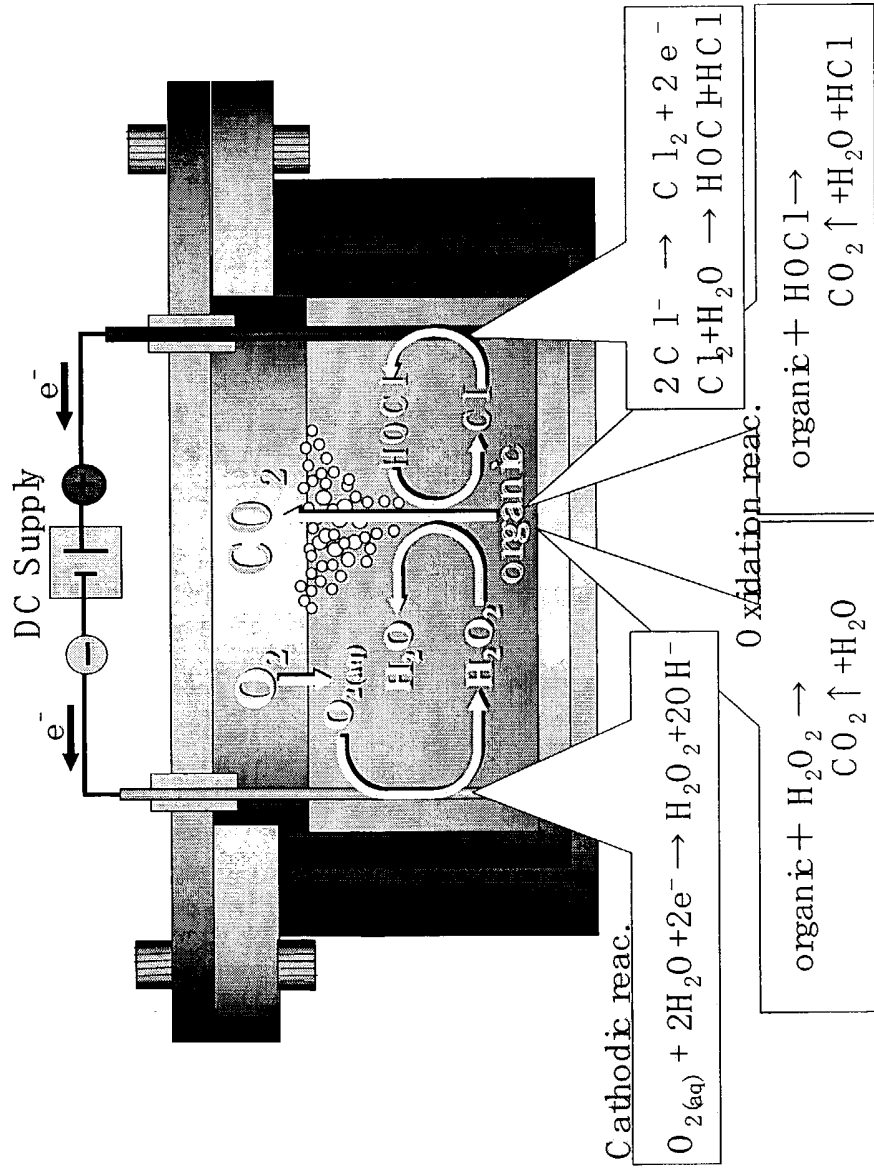
*Scheme for electrochemical reaction
of reducing compounds at hydrothermal conditions*



Electrochemical reaction of Acetic acid at hydrothermal conditions with addition of oxidizer

Experimental condition: Acetic Acid, 4,000mg/L; T, 250°C ; P, 7MPa; NaCl, 2wt%; DC, 2A





Conditions: 250°C, 7MPa for example

Electrochemical oxidation of organics with oxidizer addition

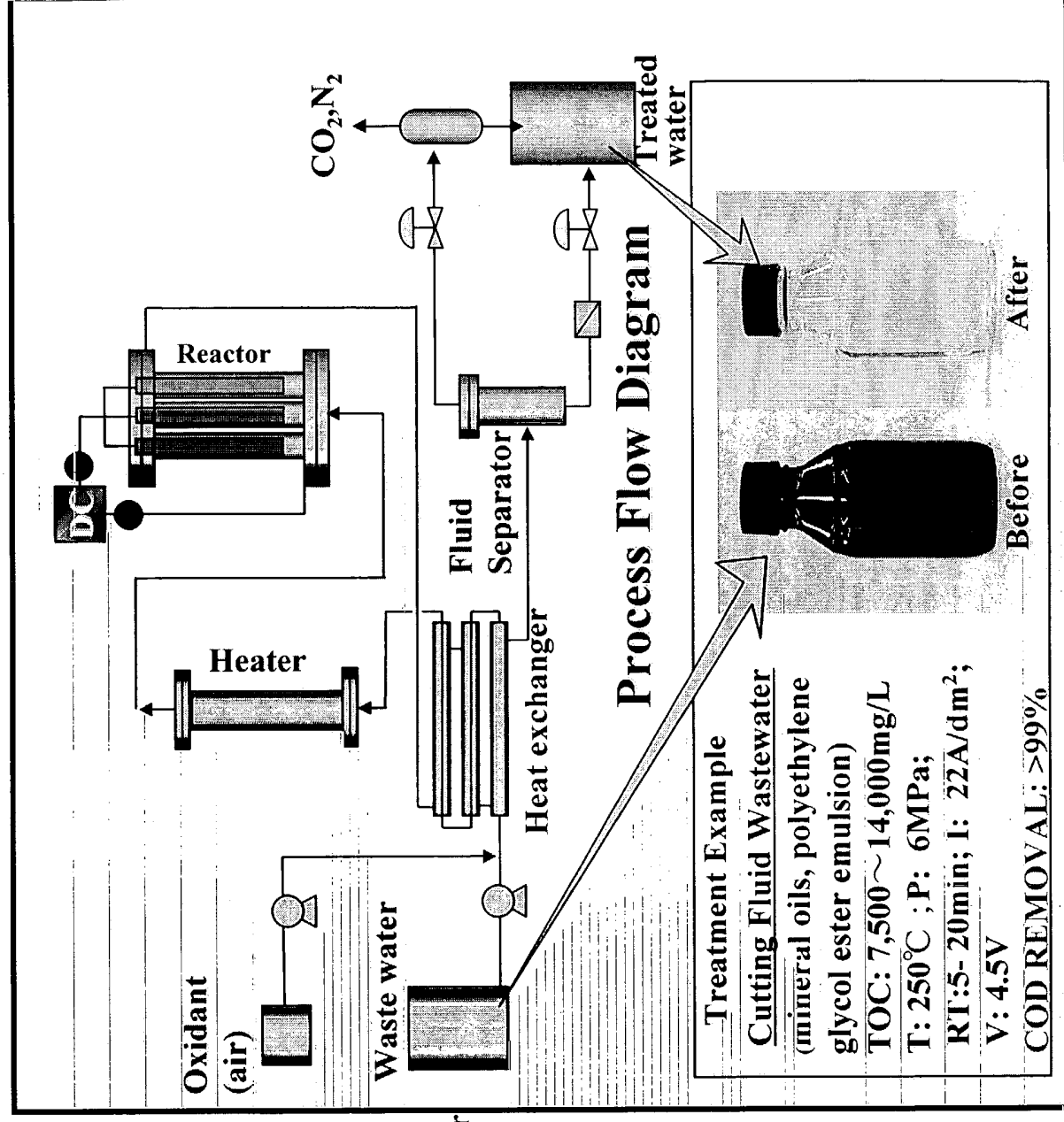
*Scheme for electrochemical reaction
of reducing compounds at hydrothermal conditions*

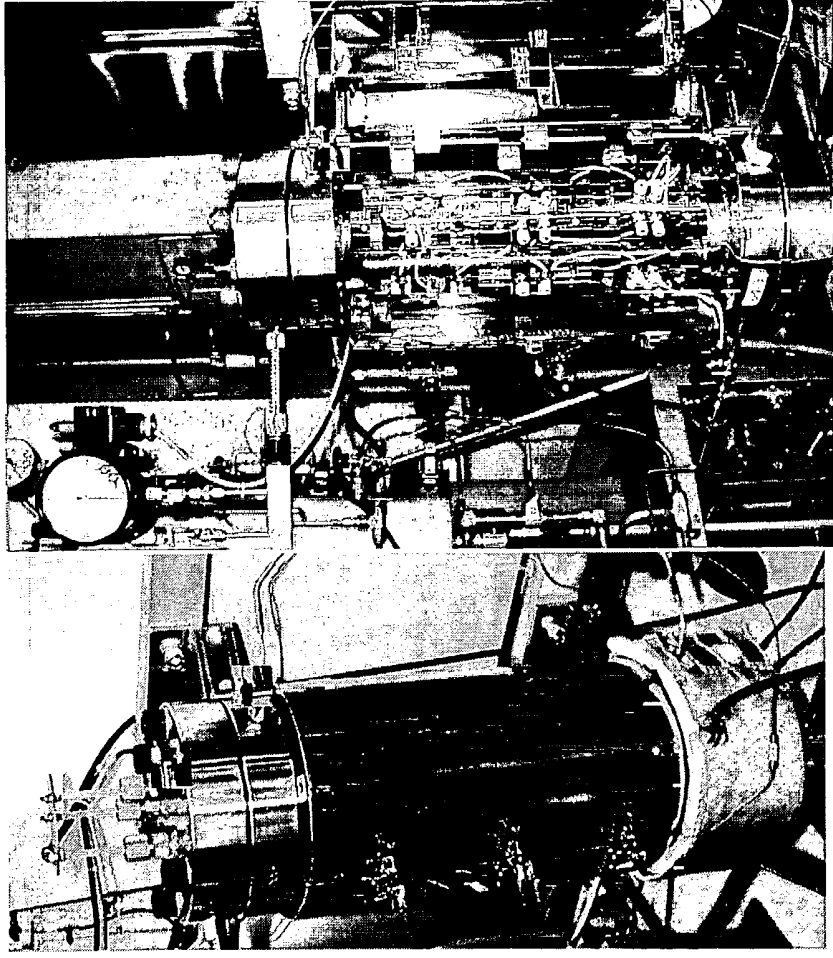
Hydrothermal Electrolytic Oxidation Process

A new treatment technology for refractory industrial wastewater

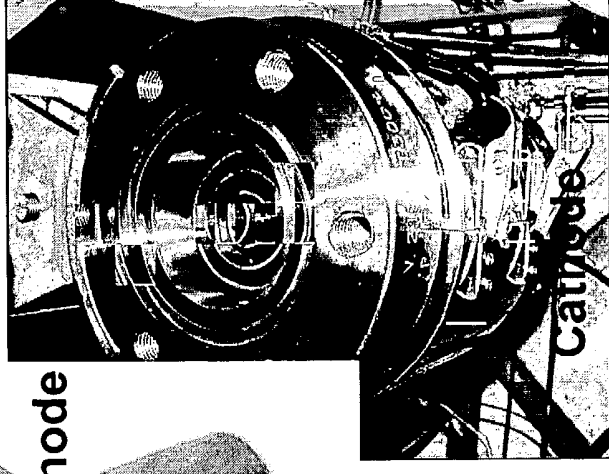
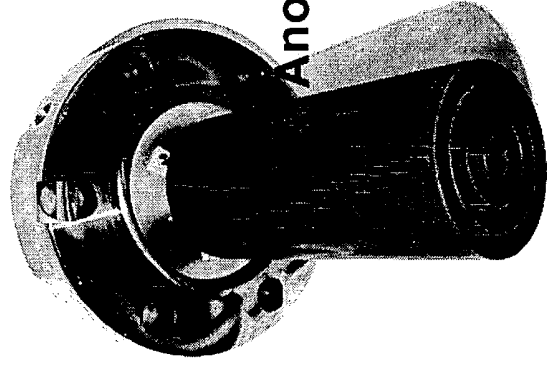
- Complete removal of wastewater COD to innocuous CO_2 , N_2 and water
- High decomposition rate (over 99%)
- Short residence time (5 to 20min)
- Mild reaction condition (100-374°C, 3-25MPa)
- Closed system
- Compact installation
- Costly competitive process
- High safety installation (Low voltage electrolysis, system inter-lock)

- Highly loaded COD wastewater
- Wastewater with high salt contents
- Example:
Semi-conductor industry wastewater
Agro-Chemical industry wastewater
Chemical industrial industry wastewater,
Pharmaceutical industry wastewater,
Dyes wastewater,
Power plant wastewater
Cutting Fluid wastewater etc.





**Multiple cylinder electrode
reaction cell type**



**Concentric cylinder
Electrode reaction cell type**

Embodiments of Electrochemical Reactor for Hydrothermal Conditions

Examples of industrial wastewater treated by HEO

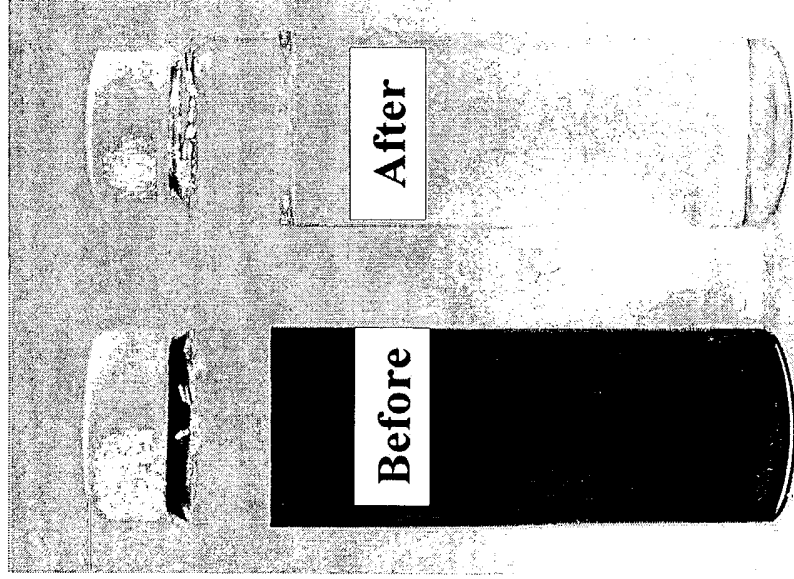
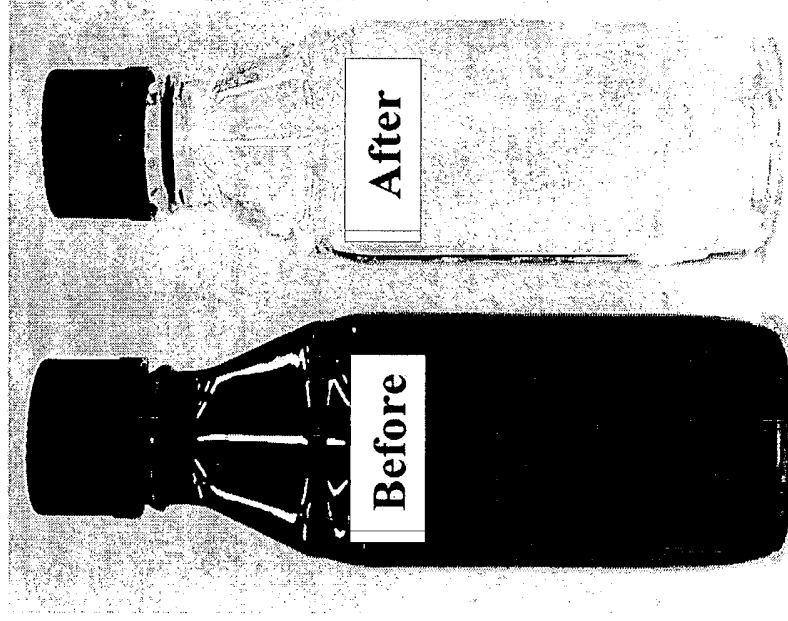


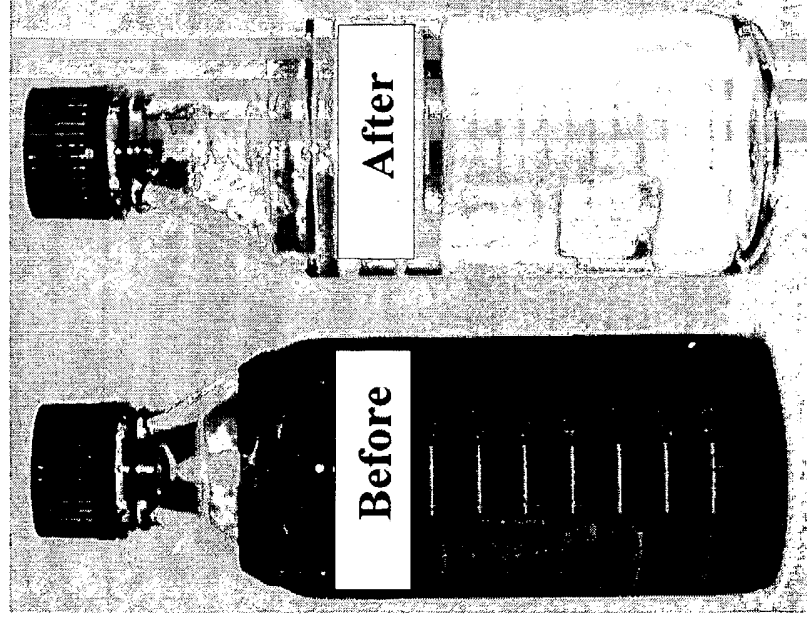
Photo & film processing
laboratory wastewater

TOC removal: 97%
COD removal: 97%
Color Removal: 99.9%



Machinery wastewater
(cutting fluid)

N-Hex removal: 99%
TOC removal: 95%
COD removal: 92%
Color removal: 99.9%



Agro-chemical
Industry wastewater

AOX removal: 98%
TOC removal: 88%
COD removal: 90%
Color removal: 99%

The information disclosed here, are shown in present application and/or

1) US6,348,143(WO99/07641) Serikawa et Al, incorporated in

entirety to this application

2) Serikawa et al., J.Applied Electrochemistry, 30, July 2000,

pg 875-883

Thank you for interview opportunity
And you kind attention